

I. Claim:

1. A dry ice feeding apparatus, comprising:
 - a. a hopper adapted to store a supply of dry ice pieces, said hopper having an upper opening and a lower opening;
 - b. a lid adapted to cover said upper opening of said hopper, said lid including a seal member providing a fluid seal between said lid and said upper opening of said hopper; and
 - c. a mixing chamber disposed beneath said lower opening of said hopper, said mixing chamber including
 - 10 a mixing cavity,
 - a dry ice inlet in fluid communication with said mixing cavity and said lower opening of said hopper and adapted to permit dry ice pieces to be supplied from said hopper to said mixing cavity,
 - 15 a fluid inlet adapted to connect a supply of pressurized gaseous fluid to said mixing cavity, and
 - a fluid outlet adapted to connect said mixing cavity to a blast gun or other dispensing device,
- 20 said mixing chamber directing flow of the pressurized gaseous fluid from said fluid inlet through said mixing cavity and out said fluid outlet and permitting dry ice pieces supplied from said hopper to said mixing cavity to become entrained in the gaseous fluid flowing through said mixing cavity and out said fluid outlet, said dry ice inlet of said mixing chamber further providing a fluid connection between said fluid inlet of said mixing chamber and said hopper to permit the gaseous fluid to pressurize said hopper when said lid seals said upper opening of said hopper.

-16-

2. The apparatus of claim 1, wherein the supply of pressurized gaseous fluid is compressed air.

3. The apparatus of claim 2, further comprising a pressure regulator connected to said hopper, said pressure regulator limiting the air pressure within said hopper to a predetermined maximum pressure.

4. The apparatus of claim 3, wherein said predetermined maximum pressure is about 125 psi.

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5. The apparatus of claim 1, further comprising a metering valve disposed between said lower opening of said hopper and said mixing chamber, said metering valve controlling supply rate of dry ice pieces from said hopper to said mixing chamber.

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6. The apparatus of claim 5, wherein said meter valve includes a housing having arcuate side walls, a rotor contained in said housing, and a plurality of vanes extending radially outward from said rotor.

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7. The apparatus of claim 6, wherein the majority of said vanes are dimensioned to provide a clearance of about 0.08 inch with respect to said arcuate side walls of said housing when said rotor rotates.

8. The apparatus of claim 7, wherein one of said vanes is dimensioned to provide a clearance substantially less than 0.08 inch with respect to said arcuate side walls of said housing.

5 9. The apparatus of claim 7, wherein one of said vanes is dimensioned to provide a clearance of about 0.005 inch with respect to said arcuate side walls of said housing.

10. 10. The apparatus of claim 6, further comprising an air motor for rotating
10 said rotor.

11. 11. The apparatus of claim 1, further comprising a size-reducing device disposed between said lower opening of said hopper and said mixing chamber, said size-reducing device controlling the size of dry ice pieces supplied from said hopper
15 to said mixing chamber.

12. 12. The apparatus of claim 11, wherein said size-reducing device is a crushing device having alternating stationary blades and rotating blades.

20 13. 13. The apparatus of claim 12, wherein said stationary blades are spaced from one another by about 0.125 inch.

14. 14. The apparatus of claim 12, wherein one or more of said rotating blades has a concave leading edge.

15. A dry ice feeding apparatus, comprising:
 - a. a hopper adapted to store a supply of dry ice pieces, said hopper having a substantially cylindrical upper portion, a frusto-conical lower portion depending downwardly from said upper portion of said hopper, and a head portion disposed atop said upper portion of said hopper, said hopper also including an upper opening in said head portion to provide access for loading dry ice pellets into said hopper and a lower opening at the bottom of said lower portion;
 - b. a lid adapted to cover said upper opening of said hopper, said lid including a seal member providing a fluid seal between said lid and said upper opening of said hopper; and
 - c. a mixing chamber disposed beneath said lower opening of said hopper, said mixing chamber including
 - a mixing cavity,
 - a dry ice inlet in fluid communication with said mixing cavity
- 15 and said lower opening of said hopper and adapted to permit dry ice pieces to be supplied from said hopper to said mixing cavity,
 - a fluid inlet adapted to connect a supply of compressed air to said mixing cavity, and
 - a fluid outlet adapted to connect said mixing cavity to a blast gun or other dispensing device,
- 20 said mixing chamber directing flow of the compressed air from said fluid inlet through said mixing cavity and out said fluid outlet and permitting dry ice pieces supplied from said hopper to said mixing cavity to become entrained in the air flowing through said mixing cavity and out said fluid outlet, said dry ice inlet of said mixing chamber further providing a fluid connection between said fluid inlet of said

mixing chamber and said hopper to permit the compressed air to pressurize said hopper when said lid seals said upper opening of said hopper.

16. The apparatus of claim 15, wherein said head portion, cylindrical upper
5 portion, and frusto-conical lower portion of said hopper comprise a welded stainless steel pressure vessel.

17. The apparatus of claim 15, wherein the wall of said lower portion of said hopper forms an angle greater than 65° from a horizontal line when the axis of
10 said frusto-conical section is vertical.

18. The apparatus of claim 15, wherein said lid covers and seals said upper opening of said hopper from inside said hopper.

15 19. The apparatus of claim 19, wherein:
said upper opening of said hopper includes a lip extending upwardly from said head portion of said hopper, said lip terminating with a horizontal lip flange; and

20 said lid includes a peripheral lid flange and a seal member disposed on the upper surface of said lid flange, said seal member being configured to contact and mate with both the upper surface of said lid flange and the lower surface of said lip flange when said lid is disposed within said hopper and urged upwardly to cover said upper opening of said hopper.

-20-

20. The apparatus of claim 19, further comprising a latching member mounted on said lid for securing said lid in place with said seal member compressed between said lid flange and said lip flange.

5 21. The apparatus of claim 20, wherein said latching member comprises a wire handle pivotally attached to said lid.

22. The apparatus of claim 19, wherein said lip flange and said lid flange are oval.

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23. The apparatus of claim 15, wherein said seal member comprises an O-ring.

24. A method of feeding dry ice pieces to a blast gun or other dispensing device, comprising the steps of:

a. providing a supply of dry ice pieces in a sealable pressure chamber having an opening in its bottom for the exit of dry ice pieces from the pressure chamber due to gravity;

b. providing a supply of clean, dry compressed air to a mixing chamber that is in flow communication with the opening in the bottom of the pressure chamber, the mixing chamber having an outlet connected to the blast gun or other dispensing device;

c. allowing the clean, dry compressed air supplied to the mixing chamber to pressurize the pressure chamber; and

d. directing a flow of the clean, dry compressed air across the mixing chamber and out of the outlet, whereby dry ice pieces exiting the opening in the bottom of the pressure vessel become entrained in the compressed air flow through the mixing chamber and exit the mixing chamber through the outlet to the
5 blast gun or other dispensing device.

25. The method of claim 25, further comprising the step of controlling the exit of dry ice pieces from the pressure vessel to the mixing chamber with a metering valve disposed between the opening in the bottom of the pressure vessel and the
10 mixing chamber.

26. The method of claim 25, further comprising the step of controlling the size of dry ice pieces exiting from the pressure vessel to the mixing chamber with a size-reducing device disposed between the opening in the bottom of the pressure
15 vessel and the mixing chamber.